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PLIOCENE PARALIC ENVIRONMENTS OF IRPINIA-DAUNIA BASIN (BARONIA MOUNTAINS, SOUTHERN APENNINES, ITALY)

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Abstract. This paper describes and interprets two stratigraphic sections across the regressive part of Baronia Synthem, located near the villages of Flumeri and Vallesaccarda (Ariano Irpino area, Southern Italy). Four different depositional environments have been recognized: fluvial, lagoon, foreshore and shoreface. Fluvial deposits, occurring in the Flumeri section, consist of clast-supported conglomerates, horizontal laminated sands and muddy silts with freshwater ostracod assemblages, indicating deposition in braided river low-sinuosity channels. In the Flumeri section lagoonal deposits are generally represented by structureless layers of dark clay including ostracods of brackish coastal lagoon connected with shallow-marine waters. In the Vallesaccarda section lagoonal sediments only occur as muddy clasts. Foreshore deposits are represented by well sorted yellow sands with low-angle cross lamination; a horizontal layer of stratified gravels outcrops in Vallesaccarda section. The shoreface deposits consist of poorly sorted sands with trough cross stratification formed in a bar and trough system, of symmetric ripples layers, and of abundant mollusc shell debris; in the Vallesaccarda section a tempestite interval generated by storm activity has been found. In Flumeri section littoral and lagoonal facies assemblages alternate; in Vallesaccarda section only nearshore sediments crop out. Nearshore deposits denote a wave-dominated coastal marine environments. These data contribute to a better knowledge of the distribution of paralic facies on the Western margin of the Pliocene Irpinia-Daunia Basin.

Riassunto. In questo lavoro vengono discussi i dati sedimentologici e paleoecologici relativi a due sezioni stratigrafiche riferibili alla parte regressiva del Sintema della Baronia ubicate presso gli abitati di Flumeri e Vallesaccarda (Irpinia, Italia meridionale). Nell'ambito delle successioni clastiche sono stati individuati quattro ambienti deposizionali: fluviale, lagunare, marino di battigia e di spiaggia sommersa. I depositi fluviali affioranti soltanto nella sezione di Flumeri sono costituiti da conglomerati clasto-sostenuti, sabbie e siltiti argillose con ostracofaune dulcicole indicative di una deposizione in canali fluviali intrecciati. I depositi lagunari della sezione di Flumeri sono generalmente rappresentati da livelli di argille scure includenti ostracofaune salmastre; nella sezione di Vallesaccarda i sedimenti lagunari affiorano esclusivamente sotto forma di clasti pelitici. I depositi di spiaggia sono generalmente sabbiosi, di battigia e di spiaggia sommersa; nella sezione di Vallesaccarda si riconosce un intervallo originato da accumuli di tempesta. Nella sezione di Flumeri si registra un alternarsi di facies marginali (spiaggia e retrospiaggia) mentre a Vallesaccarda affiorano soltanto depositi di spiaggia; in entrambi i casi i depositi di spiaggia evidenziano un ambiente marino costiero dominato dall'azione delle onde. Questo lavoro fornisce un contributo alla conoscenza della distribuzione delle facies paraliche lungo il margine occidentale del bacino irpino-dauno durante il Pliocene.

Introduction and Regional Geologic Setting

The Apennine chain is an arcuated system, characterized by Africa-verging nappes, which evolved in a post-collisional tectonic context during the Mio-Pliocene. The present arrangement of the Southern Apennines is prevalently due to compressive and traslative tectonic phases from late Tortonian to early Pleistocene, controlled by the flexural foreland plate roll-back, associated with the extension of the backarc Tyrrhenian basin (Malinverno & Ryan 1986; Patacca & Scandone 1989; Cinque et al. 1993).

After the Messinian tectonic phase (Elter et al. 1975; Di Nocera et al. 1976; Patacca & Scandone 1989), the orogenic transport style, determining the overlap of the allochthonous nappes on the outer sector of the chain, originated large wedge-top and narrow

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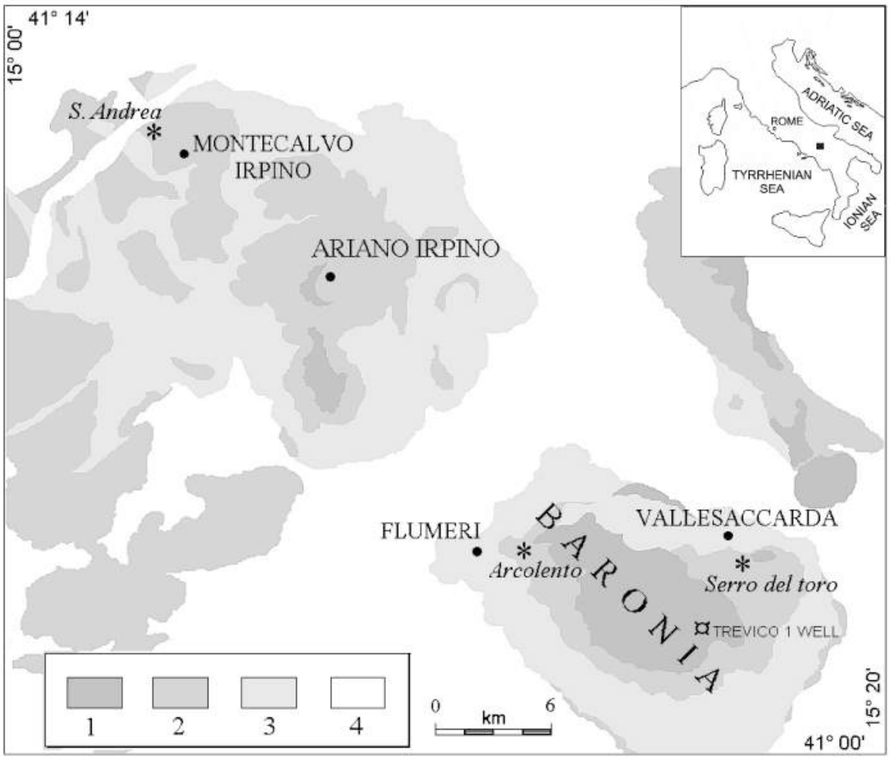


Fig. 1 - Geological sketch-map of the main lithofacies distribution in the Baronia Synthem Pliocene deposits: – 1: conglomerate; – 2: sand and sandstone; – 3: silt and clay; – 4: indifferentiated pre-Pliocene substratum and Quaternary deposits. The asterisks show the location of the studied quarry sections.

foredeep sectors in the Messinian and post-Messinian foreland basin (Patacca & Scandone 1989).

The Irpinia-Daunia basin (Ciarcia et al. 2003) is located in the Northern segment of the Southern Apenninic Arc. It pertains to the Pliocene wedge-top depocenters within a wider foreland basin system (De Celles & Giles 1996). The depocenters of the Irpinia-Daunia Pliocene basin are characterized by syndepositional compressive stress and polyphasic evolution (Ciarcia et al. 2003), as stated by Hippolyte et al. (1994) also for the contiguous Ofanto piggy-back basin.

Pliocene sedimentary sequences are well exposed especially in the outer-axial sector of the chain; they unconformably overlay several tectonic units of the orogenic wedge (Ciarcia et al. 1998; 2001). The Lower Pliocene deposits, drilled in the Trevico 1 well (AGIP Mineraria 1961), are well developed in the north-eastern Irpinian Apennines, especially in the Ariano Irpino area and in the Baronia Mountains (Fig. 1). The sedimentary record, reaching a thickness of more than 2000 m, is characterised by transgressive basal facies and very thick regressive facies (Fig. 2).

The studied successions pertain to the Pliocene Adriatic setting (Ciarcia & Torre 1996), and are part of the Baronia Synthem (Ciarcia et al. 2003) which comprises an entire sedimentary cycle. The unit, bounded by unconformities above and below, may be defined an unconformity-bounded stratigraphic unit (UBSU, Salvador 1994). Amore et al. (1998) assigned the "Baronia Unit" to the Early Pliocene, *G. puncticulata* biozone (M Pl 4a, Rio et al. 1994).

A detailed geological survey, carried out in Irpinia and Daunia areas (Campania, Southern Italy), evidenced few areally restricted outcrops of coastal lagoon deposits in the upper and regressive part of Lower Pliocene successions. Lagoonal sediments consist of both pelitic layers located between underlying marine sands and overlying alluvial conglomerates, and of mud clasts layers interpreted as storm deposits (tempestites) in nearshore sands.

In the present paper the regressive part of the sequence, previously examined in the S. Andrea section near Montecalvo Irpino by Barra et al. (1998), is studied by means of sedimentological and microfaunal analysis.

The studied sections

The Baronia Synthem consists of a lithostratigraphic succession exclusively made of clastic sediments. The succession may be subdivided, on the basis of lithological and stratigraphical features, into five members. These are, from base to top: 1) lower conglomerates with sandy and silty lenses; 2) lower sands; 3) marly and silty clays; 4) upper sands; 5) upper conglomerates with sandy and silty lenses (Fig. 2). The studied deposits belong to the upper part of the succession and are exposed in two quarries. The first section (Fig. 3) over 30 m thick is located in Arcolento, near the village of Flumeri (Fig. 1), the second one, about 15 m thick, in Serro del Toro, near Vallesaccarda.

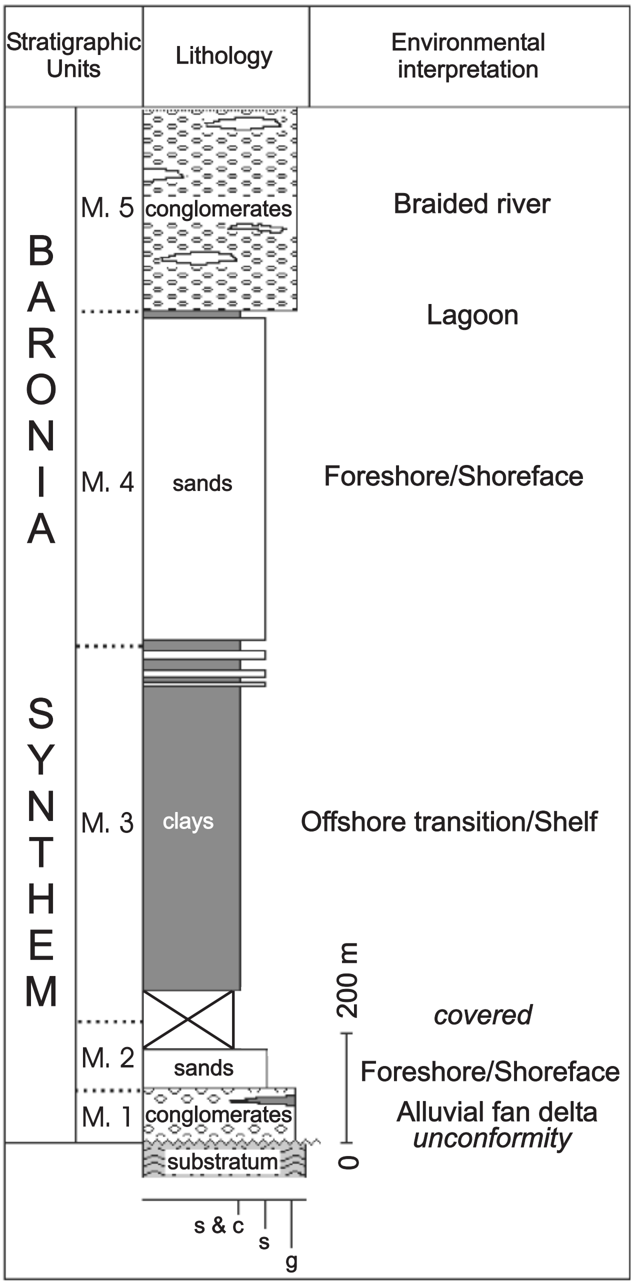


Fig. 2 - Synthetic stratigraphic log showing thickness and palaeoenvironmental interpretation of the sequence cropping out in the Baronia mountains. Sand-dominated lenses are in white, mud-dominated lenses are in black.

Facies associations

Facies acronyms are explained in Tab. 1. The facies analysis allowed the definition of four different palaeoenvironments: fluvial, lagoon, foreshore and shoreface.

Fluvial deposits

Clast-supported polygenic conglomerates, with sandy matrix and crude horizontal bedding and imbricated pebbles and cobbles (facies Gh), occur at the top of the Flumeri section. Grain size ranges between 3 and 15 cm. Layer thickness averages 50 cm. Element GB (Gravel bar, Miall 1985) predominates; the channelized conglomeratic bodies, less than 1 m thick, show a lenticular or occasionally tabular geometry, and numerous internal erosional surfaces. Channel margins are not identifiable in outcrop. The clasts are heterometric and mainly consist of sandstone and limestone pebbles and cobbles, with flow direction toward north-east (Torre & Ciarcia 1995). Layers of fine- to coarse-grained sand (facies Sh), generally with horizontal lamination, have rarely been found in association with the Gh facies. Most rarely, there are muddy silt (facies Fl) layers, somewhere laminated, with vegetal debris and fresh-water ostracod assemblages. Sh and Fl facies show frequently lens and wedge shape. The lower boundary of this fluvial interval is conformable with lagoon pelites.

In the Flumeri section, gravel deposition occurred by building and migration of longitudinal bars (Miall 1977, 1978; Rust 1978). Low-sinuosity channels, including scattered channels, are assigned to shallow gravel-bed braided rivers (Miall 1985, 1996). Sand lenses are representatives of planar bed flows (Miall 1996) or energy decreases in flow regime. The pelitic facies is attributed to overbank deposits in the floodplain, or abandoned-channel sediments.

In the Flumeri section, sandy and pelitic facies, representing the change from hypersaline lagoonal deposits to coarse-grained fluvial sediments, could be interpreted as deposited in a fluvial environment or, alternatively, in a lagoon sector near an estuary. According to the Ward & Ashley (1989) lagoon model, the lack of brackish and marine (sea-water dominated zone) sediments suggests a fluvial-dominated depositional environment.

In the Vallesaccarda section fluvial deposits have not been found.

Lagoonal deposits

Dark clays, marly-clays and silty-clays, locally grey or weathered into yellowish, structureless, occasionally showing weak horizontal bedding.

In the Flumeri section four pelitic (facies Flg) layers occur; the lower three layers range in thickness from 5 to 20 cm; the top layer is about 1.5 m thick (Fig. 3). These layers yielded ostracod assemblages, oligotypic mollusc faunas, mainly consisting of Cardiidae and turriform gastropods, and plant debris.

In the Vallesaccarda section dark grey to brownish mud clasts at the base of a sand layer (Fig. 3) yielded ostracod assemblages and biogenic fragments. The clasts are covered by a thin (3-4 mm) iron oxide brown-rusty coating associated with fine to coarse sand-size detritus.

The sedimentary features observed in the Flumeri section indicate a lagoonal, low-energy palaeoenvironment.

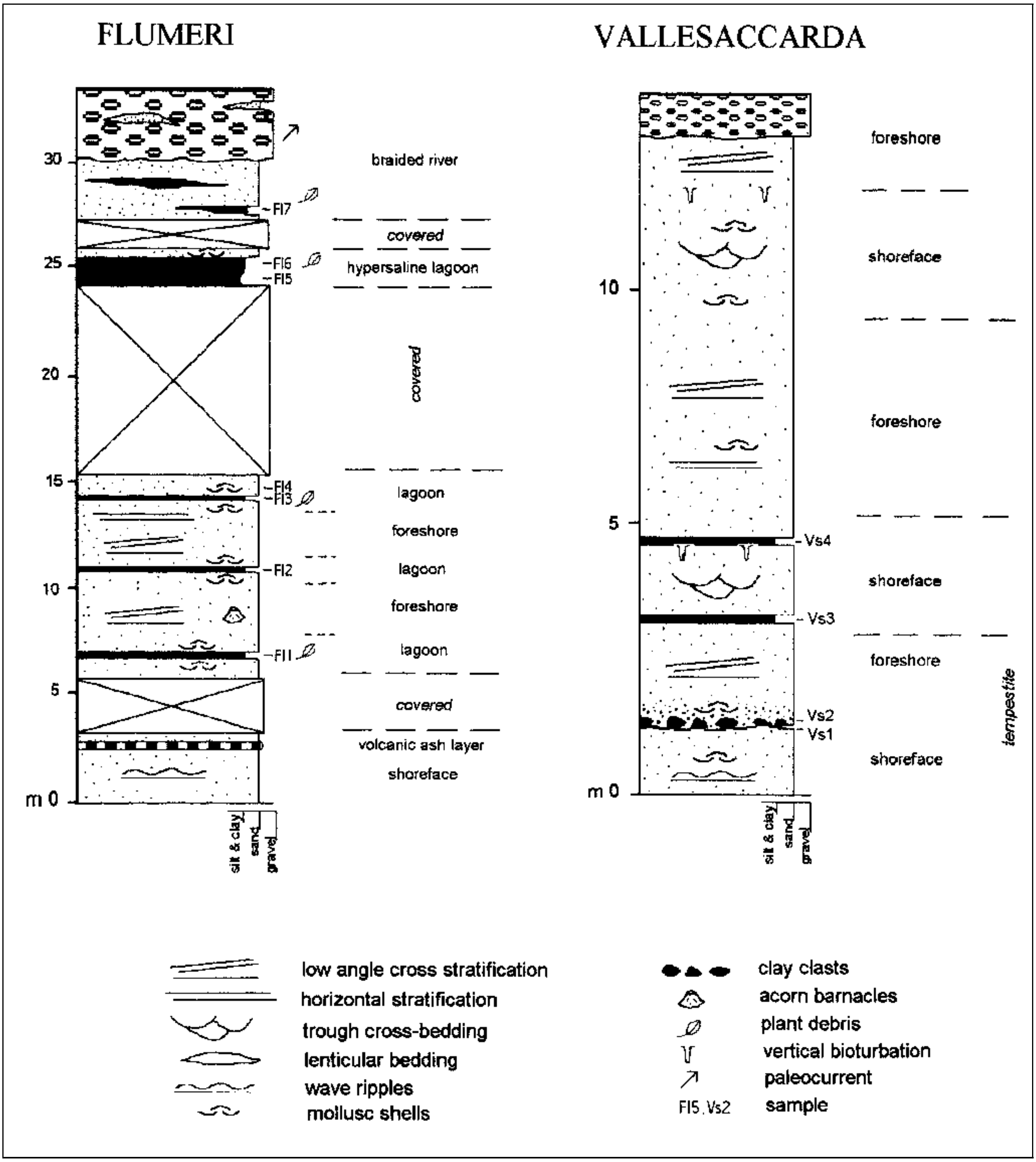


Fig. 3 - Stratigraphic logs of Flumeri section and Vallesaccarda section.

The muddy clasts, present in the Vallesaccarda section, are described in the section on Shoreface deposits.

Foreshore deposits

Medium-fine grained, well-sorted and poorly cemented yellow sands (facies Sfo), of quartzo-feldspathic composition (Barone et al. 2002).

In the Flumeri section strata boundaries are not clear; horizontal lamination and low-angle cross lamination are rarely evident. Cardiidae and Pectinidae have been commonly recovered, some specimens showing attached Balanomorpha. Further mollusc taxa are present as shell debris (e.g. *Ostrea* fragments).

In the Vallesaccarda section low-angle cross laminated sands occur, while horizontal lamination has been infrequently recorded. The top of this section is marked by a layer at least 0.3 m thick of horizontal-stratified gravel (facies Gfo). The pebbles show a polygenic com-

Tab. 1 - Sedimentary facies and palaeoenvironment interpretation.

FACIES		CHARACTER	INTERPRETATION
Gravels and conglomerates			
	Gh	Polygenic, from coarse pebble to coarse cobble size, clast-supported conglomerates with sandy matrix; crude horizontal bedding, weak grading, imbricated clasts and locally erosional basal surfaces.	Fluvial (braided stream)
	Gfo	Polygenic, horizontal stratified conglomerates; grain size range between 1 and 5 cm; well-rounded clasts with high degree of shape and size sorting; shell debris.	Foreshore
Sands and sandstones			
	Sh	Quartzo-feldspathic, medium-grained, massive or horizontal-laminated thin-bedded sandstones, in lenticular to wedge-shaped layers.	Fluvial
	Sfo	Quartzo-feldspathic, medium to fine-grained, well sorted, medium-bedded sands and sandstones; horizontal to low-angle lamination, mollusc shells.	Foreshore
	Ssh	Quartzo-feldspathic variable-grained trough cross bedded sandstones, occasional wedge-shaped set package; poorly sorted; local bioturbation.	Shoreface
Muds and mudstones			
	Fl	Parallel-laminated, lens- or wedge-shaped beds of grey muds; peat beds.	Fluvial (overbank)
	Flg	Blackish horizontally bedded marly-silty clays and clays with brackish oligotypic faunal assemblages, abundant vegetal debris (locally leaf marks). Locally occurring as clay-clasts.	Lagoon
	Fsh	Greenish-grey horizontally bedded silty clays and clays with rare fine yellow sands. Marine faunal assemblage.	Shoreface

Fig. 4 - Clay-clast level cropping out in the Vallesaccarda section.

position with dominant sandstone and limestone and are well rounded, with high degree of shape sorting; the grain size ranges between 1 and 5 cm. The uppermost conglomerates include shell debris.

Depositional features, such as sedimentary structures and high degree of size sorting, indicating foreshore environment (Reinson 1992; Reading & Collinson 1996), fit well with the characters of Pleistocene Adriatic sequences (Amorosi et al. 1998) deposited in a sheltered setting.

An intertidal environment is evidenced by the presence of acorn barnacles.

In Vallesaccarda section the horizontal-stratified foreshore gravels (cf. Massari & Parea 1988) are probably related to extensive conglomerate bodies deposited on the adjacent coastal plain (Ciarcia & Torre 1996).

Shoreface deposits

Quartzo-feldspathic and poorly sorted sands (facies Ssh) with variable grain size. Trough cross stratification is present and the individual sets are occasionally characterized by abundant shell debris.

In the lower part of the Flumeri section, a layer of symmetric ripples and, about 1 meter above, a horizon of pink-coloured volcanic ash of rhyolitic composition, about 5 cm thick, crop out. A sandy horizon, including aligned rounded and subangular clay-clasts (facies Flg) and mollusc debris (Cardiidae, Pectinidae, Ostreidae), is found near the base of the Vallesaccarda section. This layer overlies, and passes laterally into, greenish-grey sandy-clays (facies Fsh), with thickness ranging from 0.5 to 2 cm. The average size of the clay-clasts is about 2 cm; some of these clasts, subrounded and generally flattened, reach a size of 20-30 cm (Fig. 4). Lateral continuity of the clay-clast level has been observed for at least 5 meters. Greenish-grey horizontally bedded silty, clayey, rarely sandy layers (facies Fsh), 0.1-5 cm thick, are located near the boundaries with the contiguous foreshore sediments. In this section numerous subvertical biogenic structures of *Skolithos* (1-20 cm long, max diameter 2-3 cm) occur in the uppermost levels of the trough cross bedding intervals, just below the boundary with the overlying low-angle cross lamination sands. Primary sedimentary structures are frequently obliterated by bioturbation. The trough cross stratification forms, in bar and trough systems, below the low tide level or, most rarely, in rip channels, due to longshore currents or wave action.

Carobene & Brambati (1975), studying the morphology of the present Northern Adriatic beaches, described the development of longshore troughs between the lower limit of the foreshore and the first submarine bar.

An ash horizon in the Flumeri section, testifying low energy conditions in the offshore transition environment, overlies the symmetric wave ripple (Komar 1974) layers.

Clay clasts may be interpreted as semiconsolidated mud fragments ripped up from lagoon sediments, as documented by ostracod assemblages (see Palaeoecology), and deposited in longshore troughs or in rip channels, during the waning stage of storms or river floods.

The coarse-grained sandy level, including skeletal debris and rip-up clasts, is interpreted to be a high-energy deposit (tempestite); the following laminated and bioturbated sands may be laid down under relatively quiet conditions. The subrounded shape of the clasts is due to rolling movements along the bottom.

Deposition of pelitic layers could occur in a sheltered environment as a longshore trough bottom, when very fine suspended sediments fall from suspension related to the waning stage of a high-energy event (Massari 1988); the pelitic horizons in Vallesaccarda are thought to result from this depositional process.

The accumulation of leaves and debris, of subaerial plants, occurring sporadically in low-energy environments, indicate the continental influence.

In the studied successions the features of the shoreface sands do not permit the subdivision in upper, middle and lower segments of the shoreface, frequently used in sedimentological literature. This tripartition has been criticized also by Clifton (2000) who stated that, in ancient coastal successions, only the upper shoreface is commonly recognized in the absence of gravel deposits.

Palaeoecology – the ostracod fauna

Material and methods

Eleven samples were studied, seven from the Flumeri section and four from the Vallesaccarda section, collected from the pelitic layers (Fig. 3). All the samples (each of 200 gr dried weight) were disaggregated and washed with water through 230 and 120 mesh sieves (63 μm and 125 μm respectively). All the ostracods were picked in the coarsest fraction (> 125 μm), the species identified and the adult specimens counted.

Palaeoecological interpretations are based on data published in papers concerning the distribution of paralic/shallow-marine ostracods (i.a. Carbonel 1982; Maddocks 1995; Barra et al. 1998; Boomer & Eisenhauer 2002; Smith & Horne 2002, and references).

The studied specimens are housed in the Aiello Barra Micropaleontological Collection (A.B.M.C.), Dipartimento di Scienze della Terra, Università degli Studi di Napoli "Federico II", Naples.

Results

The ostracod fauna consists of 25 species, 22 of them recorded from the Flumeri section (Tab. 2) and 11 from the Vallesaccarda section (Tab. 3). 14 species are present only in the assemblages of Flumeri, 4 species have been found exclusively in Vallesaccarda and 7 species are in common. 7 species have been tentatively identified due to the sparse or poorly preserved nature of the material; 5 species and 1 subspecies, probably new, have been left in open nomenclature. The taxon-

Tab. 2 - Distribution of the ostracod fauna recorded in the Flumeri section. The letter "j" indicates the presence of juvenile specimens.

Flumeri

Species	Fl 1	Fl 2	Fl 3	Fl 5	Fl 6	Fl 7
Aurila convexa (Baird, 1850)	2 j	5	1			
Aurila hesperiae Ruggieri, 1973 subsp. nov.	3 j	9 j	3 j			
Cyprideis calabra Decima, 1964	4 j	1 j	j	9 j	24 j	
Euxinocythere (M.) nasseri Barra & Bonaduce, 1998	2	1 j	9 j			
Hemicytheria sp. nov. 1		2	1 j			
Hiltermannicythere ? turbida (G.W. Mueller, 1894)			j			
Ilyocypris bradyi Sars, 1890						1
Leptocythere bacescoi (Rome, 1942)	5j	1	11j			
Leptocythere lagunaris Barra & Bonaduce, 1998			5			
Leptocythere ? punctatella B., M. & P., 1977	1					
Leptocythere sp. nov. 1	8j	3j	17j			
Leptocythere sp.	j					
Loxoconcha sp. nov. 1	16 j	5				
Loxoconcha sp. nov. 2	4	2 j	2 j			
Loxoconcha sp.		1	1 j			
Miocyprideis italiana Moos, 1962	11	1				
Palmoconcha turbida (G.W. Mueller, 1912)	13 j		4 j			
Pseudocandona ? sarsi (Hartwig, 1899)						2
Pseudocandona sp.						4
Semicytherura sp. nov. 1	2					
Urocythereis crenulosa (Terquem, 1878)		1				
Xestoleberis margaritea (Brady, 1866)	7 j	2 j	5 j			

Tab. 3 - Distribution of the ostracod fauna recorded in the Vallesaccarda section. The letter "j" indicates the presence of juvenile specimens.

Vallesaccarda

Species	Vs 1	Vs 2	Vs 3	Vs 4
Aurila punctata Muenster, 1830	2			
Callistocythere sp.			1	
Cyprideis calabra Decima, 1964	1 j	44 j	1	1 j
Cytheretta sp.	j			
Euxinocythere (M.) nasseri Barra & Bonaduce, 1998		3		
Hemicytheria sp. nov. 1		13 j		
Leptocythere lagunaris Barra & Bonaduce, 1998		2		
Loxoconcha sp. nov. 2		1 j		
Palmoconcha turbida (Mueller, 1912)		1 j		
Pontocythere turbida (G.W. Mueller, 1894)			3	
Urocythereis crenulosa (Terquem, 1878)		1		

omy of these assemblages will be the subject of a subsequent study (Aiello & Barra in progress).

Flumeri section. The assemblages recovered in the pelites of the lower part of the Flumeri section (samples Fl1, Fl2, Fl3) show the highest abundance and diversity. The ostracods present in these samples are represented by well preserved shells pertaining both to young instars and adult specimens. These features clearly indicate that the assemblages are autochthonous.

In this interval the dominant taxa are: *Aurila hesperiae* n. ssp. 1, *A. convexa*, *Euxinocythere (Maeotocythere) nasseri*, *Leptocythere bacescoi, Leptocythere* n. sp. 1, *Loxoconcha* n. sp. 1, *Loxoconcha* n. sp. 2, *Miocyprideis italiana*, *Palmoconcha turbida*, *Xestoleberis margaritea*.

In the middle part of the Flumeri section the sample Fl4 is devoid of ostracods, while rare specimens of the benthic foraminiferal genus *Ammonia* are present.

Two samples (Fl5 e Fl6) of the upper part of the section showed a monospecific ostracod fauna with *Cyprideis calabra*, while in the uppermost pelitic layer (Fl7) rare valves of *Ilyocypris bradyi* and *Pseudocandona* spp. have been found.

The ostracod assemblages recorded in Flumeri are indicative of a marginal marine environment and are closely related to the paleosalinity. Consequently the species have been arranged in 4 groups, according to their ecological and palaeoecological meaning.

The group A includes taxa of shallow-marine and/or polyhaline waters. They are: *Aurila hesperiae* n. ssp. 1, *A. convexa, Hiltermannicythere? turbida, Leptocythere bacescoi*, *Leptocythere? punctatella, Leptocythere* n. sp. 1, *Leptocythere* sp., *Loxoconcha* n. sp. 2, *Loxoconcha* sp., *Palmoconcha turbida, Semicytherura* n. sp. 1, *Urocythereis crenulosa, Xestoleberis margaritea*.

In the group B only *Cyprideis calabra* has been placed. On the basis of the previously known distribution of *C. calabra* (Decima 1964, described as *C. tuberculata calabra*; Carbonnel 1979 as *C. anlavauxensis;* Barra et al. 1998 as *C.* gr. *torosa;* Gliozzi 1999 as *C.* aff. *C. tuberculata)*, and according to the recent and fossil distribution of the genus *Cyprideis* and especially of *C. torosa*, which is a species quite similar to *C. calabra*, we regard the latter species as possibly holoeuryhaline.

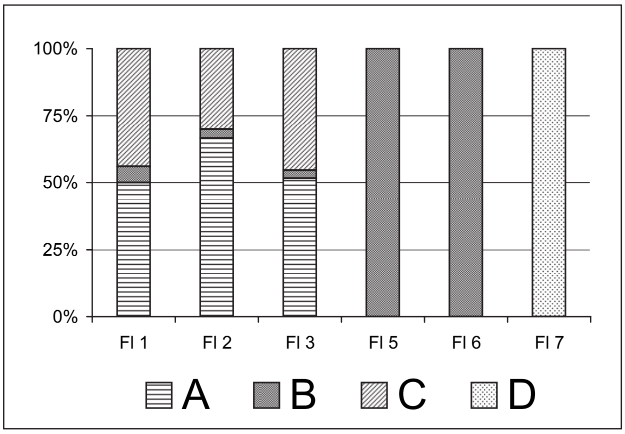


Fig. 5 - Histogram of assemblages percent composition in the Flumeri section, according to the palaeoecological groups A, B, C and D defined in the text.

The group C comprises species occurring exclusively in non-marine, brackish, assemblages. They are: *Euxinocythere (M.) nasseri, Hemicytheria* n. sp. 1, *Miocyprideis italiana, Leptocythere lagunaris, Loxoconcha* n. sp. 1 (as *L.*? *krajinae* in Barra et al. 1998).

The group D includes only 3 species pertaining to freshwater taxa: *Ilyocypris bradyi, Psaeudocandona*? *sarsi, Pseudocandona* sp.

In the lower part of the section (samples Fl1 – Fl3), the groups A and C dominate the assemblages; the group B is present, indicating nearly polyhaline waters (Fig. 5). The inferred palaeoenvironment is a brackish coastal lagoon connected with shallow-marine waters.

The finding of specimens pertaining to *Miocyprideis* is noteworthy, due to the distribution of the recent species of the genus, living exclusively in marginal waters under the tropical climate of the Indo-Pacific (Brady 1880; Fyan 1916; Keij 1954; Kollmann 1960; Malz & Ikeya 1986; Khosla 1988; Jellinek 1993; Maddocks 1995) and Atlantic coasts (Carbonnel 1982; 1986; Witte 1993).

In the samples Fl5 and Fl6 monospecific assemblages with *C. calabra* were found. They could be interpreted as hypersaline-water fauna of salt water lagoonal palaeoenvironment.

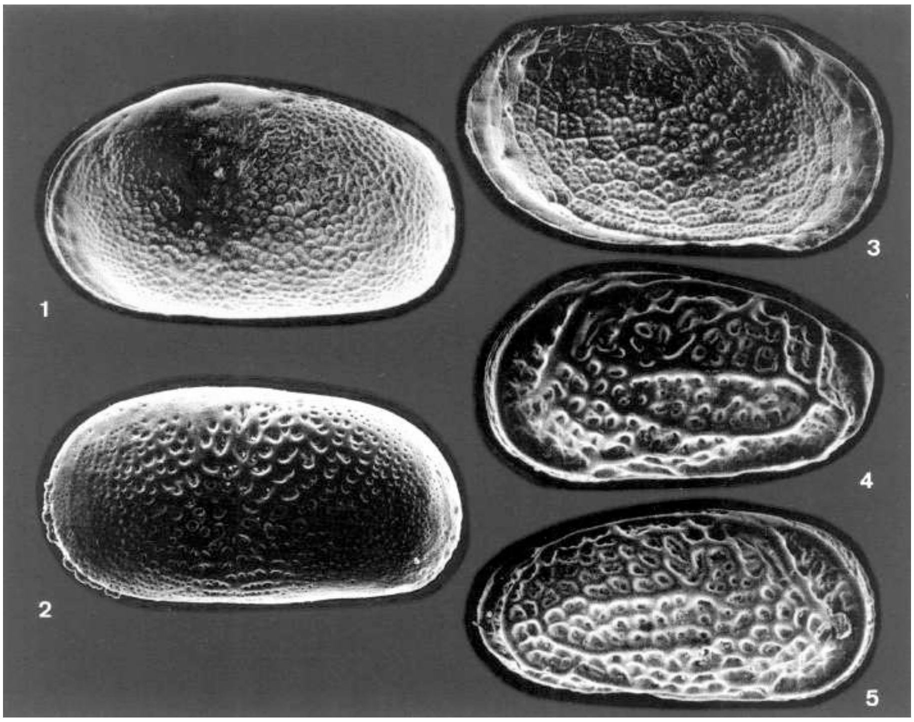
In the upper part of the section (sample Fl7) only limnic species (group D) are present, indicating that the depositional environment was fed by continental freshwater, without marine water influence.

Vallesaccarda section. In the Vallesaccarda section only the ostracod fauna occurring in the sample Vs2 shows relatively high diversity and abundance, with 7 species and 65 specimens. *C. calabra* and *Hemicytheria* n. sp. 1 characterize the assemblage together with *E. (M.) nasseri* e *L. lagunaris*, mixohaline species indicating brackish water.

In this assemblage, recovered in the clay clasts, the specimens of *C. calabra* are both smooth (17 valves) and reticulated (29 valves). Carbonel (1982) estabilished a connection between the presence of reticulated specimens of *Cyprideis* and waters with high Mg^{++}/Ca^{++} ratio which are common in marginal environment, in a dry climate. In a temperate climate these conditions are typical of partially isolated environments.

The ostracod valves, pertaining to sublittoral taxa, occurring in the pelitic layers (samples Vs1, Vs3, Vs4), are very rare and their state of preservation is poor. Consequently, they seem to represent an allochthonous

Fig. 7 - SEM micrographs of selected paralic ostracod species.
1. *Cyprideis calabra* Decima, left valve, female, sample Vs2, A.B.M.C. 20, (× 56);
2. *Miocyprideis italiana* Moos, left valve, sample Fl1, A.B.M.C. 23, (× 71);
3. *Loxoconcha* n. sp. 1, right valve, male, sample Fl1, A.B.M.C. 34, (× 128);
4. *Euxinocythere* (*Maeotocythere) nasseri* Barra and Bonaduce, left valve, sample Fl3, A.B.M.C. 37, (× 132);
5. *Leptocythere lagunaris* Barra and Bonaduce, RV, sample Fl 3, A.B.M.C. 38, (× 138).



thanatocenosis deposited in longshore trough rather than autochthonous shallow-marine assemblages (see Shoreface Deposits in Sedimentary facies).

The assemblages examined by Barra et al. (1998) from the outcrops of Montecalvo Irpino, show some similarity with the ostracod fauna studied in the present paper. Four species occur both in the Montecalvo Irpino and Flumeri sections (Fig. 6). They are: *C. calabra*, *Euxinocythere (M.) nasseri*, *Leptocythere lagunaris*, *Loxoconcha* n. sp. 1. The first three species occur also in the section of Vallesaccarda.

These species seem to be the most significant in the assemblages recorded in the Pliocene lagoonal brackish palaeoenvironment located on the inner margin of the Ariano Basin.

The presence of monospecific assemblages with *C. calabra* have been interpreted as indicative of hypersaline waters (salt-water lagoonal palaeoenvironment), both in Montecalvo Irpino and Flumeri sections.

Discussion and concluding remarks

The Pliocene sections of Flumeri and Vallesaccarda, as the Montecalvo Irpino section (Barra et al. 1998), have been referred to the regressive part of the Baronia Synthem (Fig. 2).

In the Flumeri section, nearshore (shoreface and foreshore) and backshore (lagoon) facies assemblages alternate, indicating reiterated landward and seaward facies migrations. The upper part of the section shows the drastic increase of coarse-grained sedimentary input, with the deposition of considerable amount of fluvial conglomerates.

In Flumeri, the overall depositional trend shows a seaward migrating facies assemblage consisting of:

– an outer zone, dominated by high-energy marine shoreface processes;

– a central zone, dominated by both marine and fluvial low energy influences, consisting of fine-grained deposits. This transitional zone is characterized by brackish water ostracod assemblages.

– an inner zone, dominated by high-energy river processes, characterized by braided-river gravels, sands and rare pelitic lenses with freshwater ostracods.

The tripartite facies pattern suggests the presence of a wave-dominated and microtidal environment, which can be interpreted as a lagoonal estuary (Reinson 1992; Dalrymple et al. 1992).

The data are also consistent with the model described by Barnes (1980) and modified by Ward & Ashley (1989), of a spatial variation in salinity in a coastal lagoon system. Neither washover deposits nor coastal dunes crop out; these backshore facies are probably not preserved (or they occur in the covered part of the section).

The fossil assemblages recovered in the Flumeri section indicate paleosalinity variations probably linked to the morphological evolution of the coastal area. However, it has to be noted that in microtidal conditions, typical of the Mediterranean sea, variations of salinity are related also to surface water circulation. For example, Pilkey et al. (1989) measured seasonal variations of salinity in a present Southern Mediterranean microtidal coastal lagoon system. Wind plays a dominant role in the circulation of the Tunisian lagoons, by periodical (generally seasonal) direction changes influencing the lagoon circulation pattern.

The presence of the genus *Myocyprideis*, presently living in shallow tropical waters, confirms previous reconstructions of the lower-middle Pliocene Mediterranean climate, warmer than present (i.a. Fauquette et al. 1998, 1999; Haywood et al. 2000). Available data seem to indicate that *Myocyprideis* is a climatic marker which disappeared from the Mediterranean area due to the Plio-Pleistocene cooling trend.

In the Vallesaccarda section, where the regressive trend may be observed only on a regional scale, shoreface facies and foreshore facies follow each other.

Two distinctive features characterize the deposits of Vallesaccarda:

– some sedimentary features are typical of storm deposits (Specht & Brenner 1979; Kreisa 1981; Aigner 1985) which are intercalated with finer-grained fair-

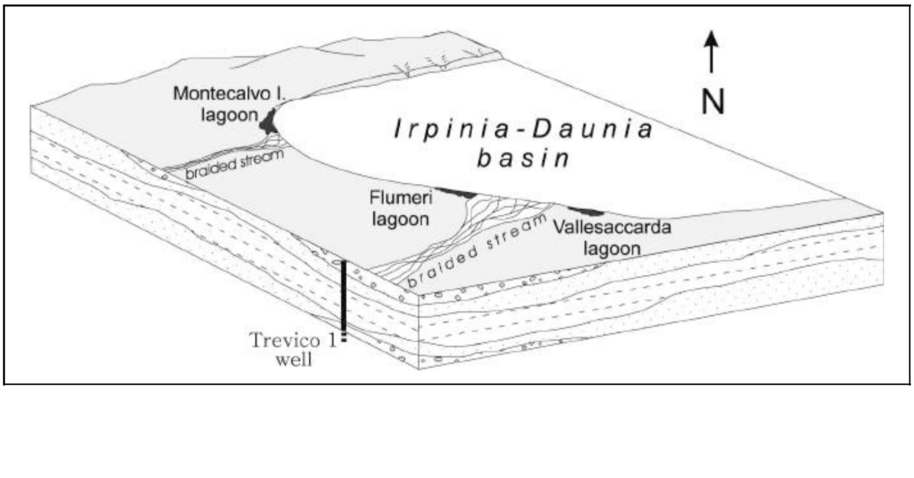


Fig. 7 - Palaeogeographic sketch of the inner margin of Irpinia-Daunia Basin.

weather deposits. Coarse-grained deposits and sedimentary structures indicate a sharp increase in energy, related to storm-generated currents. Tempestites accumulated above storm wave base, when the storm-generated currents underwent strong deceleration. Actually, a layer of rip-up clasts present in the lower part of the section, with brackish-water ostracod assemblages, occurring within the mud clasts, shows a marked affinity with the hypoaline ostracod faunas recorded in the sediments of Flumeri and Montecalvo Irpino. Clay clasts could be misinterpreted as belonging to the stratigraphically underlying shelf marine clays: the brackish ostracod assemblages, recorded in the clay clasts, indicate lagoonal deposits. As said above, these sediments cropped out in the vicinity, and it is unlikely that they were part of the Flumeri lagoon, which is far about 10 km from the site;

– the exclusive presence of elements typical of barred systems, such as rip channel, longshore bar and longshore trough (Massari & Parea 1988), suggests a generally intermediate beach state (Wright & Short 1984; Wright et al. 1986).

The bar and trough system needs a gently sloping cross-shore profile, a sand supply in the nearshore setting, a small tide range and a limited fetch or absence of long-period swell (Greenwood & Davidson-Arnott 1975). The marginal sediments studied in Vallesaccarda may have been deposited in a sheltered basin, possibly a bay of the Pliocene Adriatic Sea.

As stated by Guillen & Palanques (1993), in the Mediterranean area the bar and trough systems show high mobility, and their morphologic evolution is connected to the longshore and cross-shore (e.g. rip current) redistribution of sediments. This model fits well with the alternate facies recorded in Vallesaccarda.

In Montecalvo Irpino section (Barra et al. 1998), a regressive sequence shows the presence of lagoonal deposits overlying coastal marine sediments (nearshore facies associations underlying backshore facies associations). The stratigraphic position and environmental evolution of these deposits suggest a correlation with both Flumeri and Vallesaccarda sediments (Fig. 7).

In most of the rock sequences of the Lower Pliocene Foreland Basin System in the Southern Apennines chain, the change from shallow-marine to continental palaeoenvironments is not recognizable, due to the rare preservation of transitional sediments. These deposits have been frequently eroded and reworked during the subsequent sedimentary evolution.

The record of lagoonal deposits in the Lower Pliocene clastic successions of eastern Campania has a considerable palaeogeographic significance: the peculiar sedimentological and palaeoecological features may contribute to determine the position of the ancient coastline of the Irpinia-Daunia Basin for a length of approximately 30 km.

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